or scientific linguist would call the classicists reactionaries on the basis of their belief in "a standard of quality in English" or their respect for "the accepted great in literature." While one might quibble over whose standard and whose acceptance, there are few indeed unwilling to acknowledge both the import of the classics as part of our cultural heritage and the desirability of nicety of expression. It is not to these the modern linguist objects but to attempts to restrain, by an authoritarian dominance, the normal evolution of language. If I write "Che cou'd not i' honor passe your worde vnchallenged" I am using 17th-century verbiage sanctioned by notable literary sources, but I would be more generally intelligible if I said "I could not honorably allow your remarks to pass unchallenged," and this, as a member of the Merriam-Webster editorial staff, I do say to Marshall.

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Though the challenge is somewhat personal, Kay does help to clarify the side he takes. Try J. Donald Adams [New York *Times Book Review* (11 Feb. 1962)] and Dwight Macdonald in his searching analysis [*New Yorker* (11 Mar. 1962)], or almost any other earlier comment on Webster 3, for more detail on points to which Kay and his associates have become hypersensitized.

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Simulation of Cognitive Processes

The computer simulation of human thinking presumably described by Newell and Simon [*Science* **134**, 2011 (1961)] is questionable on a number of counts, general and specific.

In the first place, the simulation is made to seem plausible because the authors first "postulate" that human beings behave exactly like computers. Then they "discover" that they can imitate on a computer the computer-like characteristics of man they have already postulated. The human use of *symbols* implies that, on some occasions at least, a human being considers both a symbol and what it symbolizes. Newell and Simon restrict their subjects

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to symbol manipulations without meaning or understanding and then "find" that computers which do not understand the meanings of the symbols they manipulate behave exactly like human beings. It is unnecessary to say any more on this point, since there already exists in the literature a scathing indictment by O. H. Schmitt, the distinguished biophysicist, of this type of vicious-circle reasoning [*IRE National Convention, 1955* (1955), pp. 240–255].

In the second place, there is internal evidence that the experiments with the computer and subjects were not actually carried out as reported in the article. It is stated that "the subjects read the first expression, for example as, '(r) dot (tilde-p horseshoe q).' They made no use of the meanings of the expressions in their usual interpretation but simply manipulated them as organized collections of symbols." There are no parentheses around *R* in the original expression. Furthermore, unless the subjects were coached or understood the function of parentheses in symbolic logic, why didn't they read the expression as "R dot curve tilde p horseshoe q curve"? Without an understanding of grouping in symbolic logic, why should the subject say there are "two things"? Why not eight (number of symbols)? On this point, see the section on "Formality" in Quine's *Mathematical Logic*. The rules of grouping, of association, and of distribution are an important part of symbolic logic. Either the subject understood these rules or the report of the solution by symbol manipulation is contrived and not a description of an actual experiment.

A similar difficulty arises in the description of the computer program. In a program based on an algorithm, the phrase "not desirable" would be a colorful description of "reject" or "not applicable." But a so-called heuristic program would require a sharp distinction between rules which could be applied but wouldn't lead to anything ("not desirable") and rules which couldn't be applied because they were simply not applicable—that is, would lead to invalidity. Rules 3 and 4, although stated in the program to be "not desirable," are in fact "not applicable." This fact, together with the absence of formal rules for grouping and distribution, suggests strongly that the program as given in the article was never actually run on a computer.

The basic difficulty in articles of this type is that they involve what the editor of *Scientific American* has called "fraud by computer." Certainly a computer can simulate human thinking if the word *simulation* is defined as Webster has defined it: "1. Act of simulating or assuming an appearance which is feigned, or not true; pretense or profession meant to deceive. 2. Assumption of a superficial semblance, a counterfeit display."

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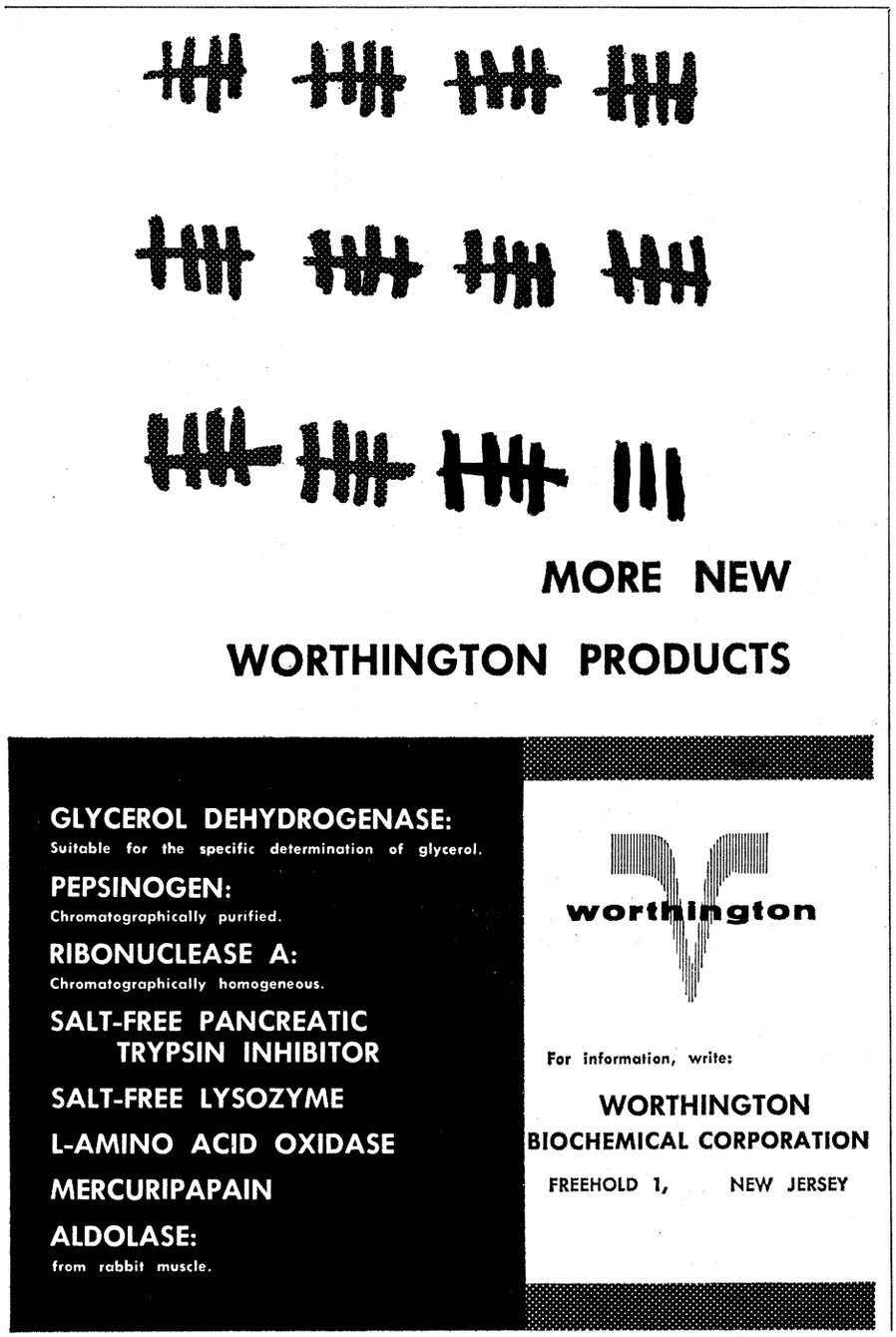
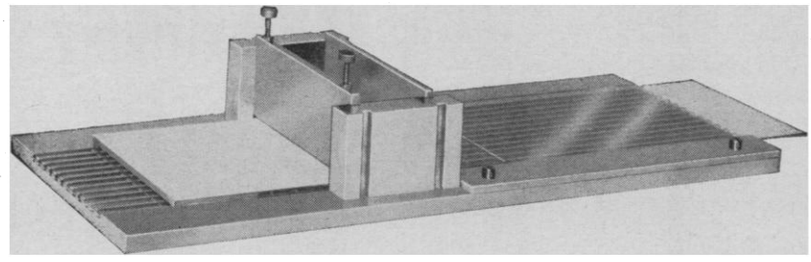
Taube, in his letter as in his book, *Computers and Common Sense*, appears to be unable to discuss the simulation of cognitive processes without words like *fraud*, insinuations about the honesty of those with whom he disagrees, and bad jokes about the word *simulation*. In view of his abusive tone, we think it fruitless to enter into discussion with him. We will limit ourselves to clarifying for readers some technical points related to his comments.

Were the logic expressions manipulated as meaningless symbols? The parenthesis signs were interpreted by both the General Problem Solver (GPS) program and the subjects—that is, treated as punctuation marks for identifying phrase structure in the logic expressions. This interpretation was built into the GPS program; the subjects had ac-





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* Ref. Analytical Chemistry, **33**, 1138 (August 1961).

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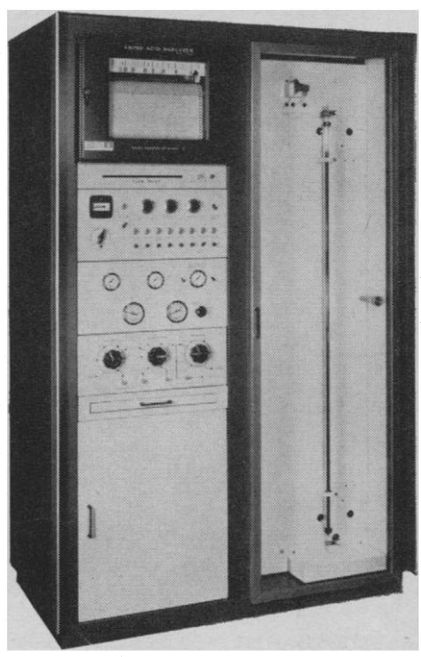

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quired it previously, presumably from their acquaintance with algebra. To this extent the expressions were meaningful to both the human subjects and the interpreter of the program.

Does the program distinguish between "undesirability" and "inapplicability" of operators? The GPS contains both tests of desirability (involving comparison of the effects of an operator with current goals) and tests of applicability (involving comparisons of the operator with the input expression). *Either* test can be applied first. If, as in the case of rule 3 or 4, an operator is neither desirable nor applicable, it will be rejected by whichever test is applied first. At the time the simulation in the *Science* article was made, the version of GPS running on the IBM 7090 gave priority to the applicability test. To fit the behavior of subject 9, a hand-simulated variant was employed that altered the relation between the two tests, producing the result shown in the trace. This is a good example of the kinds of changes in GPS that are required to adapt it to individual differences among our subjects.

We might mention that our traces of runs on the IBM 7090 (about 800 of them), our hand simulations (several dozen), our recordings of human subjects (about 30 hours), and decks or tapes of our GPS program, written in IPL-V, can be made available to fellow scientists who wish to work with them and arrive at their own interpretations.

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Recording Animal Activity

In a recent issue of *Science* [**134**, 730 (1961)], Kavanau and Norris describe an excellent application of the "capacitance-sensing" activity technique in behavior studies of burrowing animals. However, they state that "although the method is highly versatile, it apparently has not been used heretofore to study animal movements."

This method of recording animal activity was used and reported by Backlund and Ekeroot 11 years ago in a paper entitled "An actograph for small terrestrial animals" [*Oikos* **2**, 213 (1950)]. These authors used the technique to record the activity of blowflies (*Calliphora erythrocephala*), and their paper has the advantage of including